C. COHO SALMON

C.1 BACKGROUND AND HISTORY OF LISTINGS

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Coho salmon (*Oncorhynchus kisutch*) is a widespread species of Pacific salmon, occurring in most major river basins around the Pacific Rim from Monterey Bay in California north to Point Hope, AK, through the Aleutians, and from Anadyr River south to Korea and northern Hokkaido, Japan (Laufle et al. 1986). From central British Columbia south, the vast majority of coho salmon adults are 3-year-olds, having spent approximately 18 months in freshwater and 18 months in saltwater (Gilbert 1912, Pritchard 1940, Sandercock 1991). The primary exceptions to this pattern are "jacks," sexually mature males that return to freshwater to spawn after only 5-7 months in the ocean. However, in southeast and central Alaska, the majority of coho salmon adults are 4-year-olds, having spent an additional year in freshwater before going to sea (Godfrey et al. 1975, Crone and Bond 1976). The transition zone between predominantly 3-year-old and 4-year-old adults occurs somewhere between central British Columbia and southeast Alaska.

With the exception of spawning habitat, which consists of small streams with stable gravels, summer and winter freshwater habitats most preferred by coho salmon consist of quiet areas with low flow, such as backwater pools, beaver ponds, dam pools, and side channels (Reeves et al. 1989). Habitats used during winter generally have greater water depth than those used in summer, and also have greater amounts of large woody debris. West Coast coho smolts typically leave freshwater in the spring (April to June) and re-enter freshwater when sexually mature from September to November and spawn from November to December and occasionally into January (Sandercock 1991). Stocks from British Columbia, Washington, and the Columbia River often have very early (entering rivers in July or August) or late (spawning into March) runs in addition to "normally" timed runs.

Status reviews

The status of coho salmon for purposes of ESA listings has been reviewed many times, beginning in 1990. The first two reviews occurred in response to petitions to list coho salmon in the Lower Columbia River and Scott and Waddell creeks (central California) under the ESA. The conclusions of these reviews were that NMFS could not identify any populations that warranted protection under the ESA in the LCR (Johnson et al. 1991, *FR* 56(124):29553), and that Scott and Waddell creeks' populations were part of a larger, undescribed ESU (Bryant 1994, *FR* 59(80):21744).

A review of West Coast (Washington, Oregon, and California) coho salmon populations began in 1993 in response to several petitions to list numerous coho salmon populations and NMFS' own initiative to conduct a coastwide status review of the species. This coastwide review identified six coho salmon ESUs, of which the three southern most were proposed for listing, two were candidates for listing, and one was deemed "not warranted" for listing

(Weitkamp et al. 1995, *FR* 60(142): 38011). In October 1996, the BRT updated the status review for the Central California (CC) ESU, and concluded that it was at risk of extinction (NMFS 1996a). In October 1996, NMFS listed this ESU as threatened (*FR* 61(212): 56138).

In December 1996, the BRT updated the status review update for both proposed and candidate coho salmon ESUs (NMFS 1996b). However, because of the scale of the review, comanagers' requests for additional time to comment on the preliminary conclusions, and NMFS' legal obligations, the status review was finalized for proposed coho salmon ESUs in 1997 (NMFS 1997), but not for candidate ESUs. In May 1997, NMFS listed the Southern Oregon/Northern California coasts (SONCC) ESU as threatened, while it announced that listing of the Oregon Coast (OC) ESU was not warranted due to measures in the OCSRI plan (*FR* 62(87): 24588). This finding for OC coho salmon was overturned in August 1998, and the ESU listed as threatened (*FR* 63(153): 42587).

The process of updating the coho salmon status review was begun again in October 1998 for coho salmon in Washington and the lower Columbia River. However, this effort was terminated before the BRT could meet, due to competing activities with higher priorities.

In response to a petition by (Oregon Trout et al. 2000), the status of Lower Columbia River (LCR) coho salmon was revisited in 2000, with BRT meetings held in March and May 2001 (NMFS 2001a). The BRT concluded that splitting the LCR/Southwest Washington coast ESU to form separate LCR and Southwest Washington coast coho salmon ESUs was most consistent with available information and the LCR ESU was at risk of extinction. Like the 1996 status review update, these results were never finalized.

The coho salmon BRT[1] met in January, March and April 2003 to discuss new data received and to determine if the new information warranted any modification of the conclusions of the original BRTs. This report summarizes new information and the preliminary BRT conclusions on the following ESUs: Lower Columbia River, Oregon Coast, Southern Oregon/Northern California coasts, and Central California coast.

[1] The biological review team (BRT) for the updated status review for West Coast coho salmon included: Dr. Robert Iwamoto, Dr. Orlay Johnson, Dr. Pete Lawson, Gene Matthews, Dr. Paul McElhany, Dr. Thomas Wainwright, Dr. Robin Waples, Laurie Weitkamp, and Dr. John Williams, from NMFS Northwest Fisheries Science Center (NWFSC); Dr. Peter Adams, Dr. Eric Bjorkstedt, and Dr. Brian Spence from NMFS Southwest Fisheries Science Center (SWFSC); and Dr. Reginald Reisenbichler from the Northwest Biological Science Center, USGS Biological Resources Division, Seattle.

C.2.1 OREGON COASTAL COHO SALMON

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C.2.1.1 Summary of Previous BRT Conclusions

Major risk factors and status indicators

The Oregon Coastal Coho ESU has been assessed in two previous status reviews; one in 1995 (NMFS 1996a) and again in 1997 (NMFS 1997). In the 1995 status review (Weitkamp et al. 1995), the BRT considered evidence from many sources to identify ESU boundaries in coho populations from Washington to California. For the most part, evidence from physical environment, ocean conditions/upwelling patterns, marine and coded wire tag recovery patterns, coho salmon river entry and spawn timing as well as estuarine and freshwater fish and terrestrial vegetation distributions were the most informative to the ESU delineation process. Genetic information was utilized for an indication of reproductive isolation between populations and groups of populations. Based on this assessment, six ESUs were identified, including the Oregon Coast coho ESU, which includes naturally spawning populations in Oregon coastal streams north of Cape Blanco, to south of the Columbia River.

Evaluation of ESU under conditions in 1997

In 1997, there were extensive survey data available for coho salmon in this region. Overall, spawning escapements had declined substantially during the century, and may have been at less than 5% of their abundance in the early 1900s. Average spawner abundance had been relatively constant since the late 1970s, but pre-harvest abundance had declined. Average recruits-per-spawner may also have declined. Coho salmon populations in most major rivers appeared to have had heavy hatchery influence, but some tributaries may have been sustaining native stocks.

For this ESU, information on trends and abundance were better than for the more southerly ESUs. Main uncertainties in the assessment included the extent of straying of hatchery fish, the influence of such straying on natural population trends and sustainability, the condition of freshwater habitat, and the influence of ocean conditions on population sustainability. Total average (5-year geometric mean) spawner abundance for this ESU in 1996 was estimated at about 52,000. Corresponding ocean run size for the same year was estimated to be about 72,000; this corresponds to less than one-tenth of ocean run sizes estimated in the late 1800s and early 1900s, and only about one-third of those in the 1950s (ODFW 1995a). Total freshwater habitat production capacity for this ESU was estimated to correspond to ocean run sizes between 141,000 under poor ocean conditions and 924,000 under good ocean conditions (OCSRI Science Team 1996b). Abundance was unevenly distributed within the ESU at this time, with the largest total escapement in the relatively small Mid/South Coast Gene Conservation Group (GCG), and lower numbers in the North/Mid Coast and Umpqua GCGs.

Trend estimates using data through 1996 showed that for all three measures (escapement, run size, and recruits-per-spawner), long-term trend estimates were negative. More recent escapement trend estimates were positive for the Umpqua and Mid/South Coast Monitoring Areas, but negative in the North/Mid Coast. Recent trend estimates for recruitment and recruits-per-spawner were negative in all three areas, and exceed 12% annual decline in the two northern areas. Six years of stratified random survey (SRS) population estimates showed an increase in escapement and decrease in recruitment.

To put these data in a longer term perspective, ESU-wide averages in 1996 that were based on peak index and area under the curve (AUC) escapement indices, showed an increase in spawners up to levels of the mid-to-late 1980s, but much more moderate increases in recruitment. Recruitment remained only a small fraction of average levels in the 1970s. An examination of return ratios showed that spawner-to-spawner ratios had remained above replacement since the 1990 broodyear as a result of higher productivity of the 1990 broodyear and sharp reductions in harvest for the subsequent broods. As of 1996, recruit-to-spawner ratios for the 1991-1994 broods were the lowest on record, except for 1988 and, possibly, 1984. The 1997 BRT considered risk of extinction for this ESU under two scenarios: first, if present conditions and existing management continued into the foreseeable future and, second, if certain aspects of the Oregon Coastal Salmon Restoration Initiative (OCSRI) Draft Conservation Plan (Oregon Plan 1997) relating to harvest and hatchery production were implemented. The OCSRI is now (2003) called The Oregon Plan for Salmon and Watersheds.

Population abundance

Between the 1995 and 1997 status reviews, escapement increased for the ESU as a whole, but recruitment and recruits per spawner remained a small fraction of historical abundance. Spawning was distributed over a relatively large number of basins, both large and small. Natural escapement from 1990-1996 was estimated to be on the order of 50,000 fish per year in this ESU, reaching nearly 80,000 fish in 1996 coincident with drastic reductions in harvest. Pre-fishery recruitment was higher in 1996 than in either 1994 or 1995, but exhibited a fairly flat trend since 1990. The 1996 estimate of ESU-wide escapement indicated an approximately four-fold increase since 1990. When looked at on a finer geographic scale, the northern Oregon coast as of 1996, still had very poor escapement, the north/central coast showed mixed escapement with strong increases in some streams but continued very poor escapement in others, and the south/central coast continued to have increasing escapement.

Both recruitment and recruits-per-spawner had declined rapidly (12% to 20% annual declines from 1986 to 1996) in two of the three ODFW GCGs in this ESU. These declines were steeper and more widespread in this ESU than in any other coho salmon ESU for which data are available, and recruits-per-spawner continued to decline since this ESU was reviewed in 1994. The new data from 1994 to 1996 do not change the overall pattern of decline coupled with peaks in recruits-per-spawner every 4-5 years, with the height of the peaks declining through time.

Risks that this decline in recruits-per-spawner posed to sustainability of natural populations, in combination with strong sensitivity to unpredictable ocean conditions, was the most serious concern identified in 1997 by the BRT for this ESU. Some aspects of this concern were addressed by examining results of the viability models, although none of them incorporated declining recruits per spawner except as a consequence of changing ocean conditions. Preliminary results of viability models provided a wide range of results, with one model suggesting that most Oregon coastal stocks could not sustain themselves at ocean survivals that have been observed in the last 5 years, even in the absence of harvest, and another suggesting that stocks are highly resilient and would be at significant risk of extinction only if habitat degradation continues into the future. Consequently, a major question in evaluating extinction risk for this ESU was whether recent ocean and freshwater conditions would continue into the future.

Population trends and production

For this ESU, fishery recruitment forecasts for 1997 were slightly below the actual 1996 recruitment (PFMC 1997), and actual returns were drastically lower; about 25% of 1996 recruitment and the second lowest on record after 1977. Stream production studies conducted by ODFW (Solazzi and Johnson 1996) indicated that 1996 smolt production in four central coast study streams was lower than recent averages, with overwinter survival the lowest or second lowest on record for the two streams for which estimates were made, and that age-0 fish production was also low. They concluded that the "most significant impact was on juvenile coho salmon eggs that were in the gravel at the time of the [1995-96] flood." While these results were based on a small sample of streams and may not reflect average effects of the flood, they suggested that 1997 and 1998 adult returns to some coastal basins would be reduced by the floods. Longer term effects of the floods can also be expected to vary among basins, but most reports available to us suggest that long-term effects should generally be neutral or slightly beneficial (e.g. from sediment removal and increased off-channel habitat) to coho salmon.

Hatchery production and genetic risks

Widespread spawning by hatchery fish as indicated by scale data was also a major concern to the BRT. Scale analysis to determine hatchery-wild ratios of naturally spawning fish indicate moderate to high levels of hatchery fish spawning naturally in many basins on the Oregon coast, and at least a few hatchery fish were identified in almost every basin examined. Although it is possible that these data do not provide a representative picture of the extent of this problem, they represented the best information available at the time. In addition to concerns for genetic and ecological interactions with wild fish, these data also suggest natural spawner abundance may have been overestimated by ODFW and that the declines in recruits-per-spawner in many areas may have been even more alarming than current estimates indicate. However, by 1997 Oregon had made some significant changes in its hatchery practices, such as substantially reducing coho production levels in some basins, switching to on-station smolt releases, and minimizing fry releases. Uncertainty regarding the true extent of hatchery influence on natural populations, however, was a strong concern.

Another concern discussed by the BRT in 1997 was the asymmetry in the distribution of natural spawning in this ESU, with a large fraction of the fish occurring in the southern portion and relatively few in northern drainages. Northern populations were also relatively worse off by almost every other measure: steeper declines in abundance and recruits-per-spawner, higher proportion of naturally spawning hatchery fish, and more extensive habitat degradation.

Habitat conditions

With respect to habitat, the BRT had two primary concerns: first, that the habitat capacity for coho salmon within this ESU has significantly decreased from historical levels; and second, that the Nickelson and Lawson (1998) model predicted that, during poor ocean survival, only high quality habitat is capable of sustaining coho populations, and subpopulations dependent on medium and low quality habitats would be likely to go extinct. Both of these concerns caused the BRT to consider risks from habitat loss and degradation to be relatively high for this ESU.

Influence of OCSRI

The 1997 BRT considered only two sets of measures from the OCSRI: harvest management reforms and hatchery management reforms. The BRT did not consider the likelihood that these measures would be implemented; rather, it only considered the implications for ESU status if these measures were fully implemented as described. In order to carry out these evaluations, the BRT made the following assumptions:

1) The ocean harvest management regime would be continued as proposed into the foreseeable future, not revised in the year 2000 as stated in the plan. Without this assumption, effects of the plan beyond 2000 could not be evaluated.

2) Hatchery releases would continue at or below 1997 release levels (including approximately 1 million annual fry releases) into the foreseeable future.

3) The goals of maintaining naturally-spawning hatchery fish at less than 10% or 50% of natural escapement (depending on genetic similarity with natural fish) would be achieved and demonstrated by effective monitoring.

Some members had a strong concern that we do not know enough about the causes of declines in run size and recruits per spawner to be able to directly assess the effectiveness of specific management measures.

Harvest measures

Some members of the BRT felt that the harvest measures were the most encouraging part of the plan, representing a major change from previous management. However, there was concern that the harvest plan might be seriously weakened when it was re-evaluated in the year 2000, concern that combining the Umpqua and south/central coast GCGs into a larger aggregate (as would occur in the proposed harvest plan) might not adequately protect genetic diversity, and concern about our ability to effectively monitor non-target harvest mortality and to control overall harvest impacts.

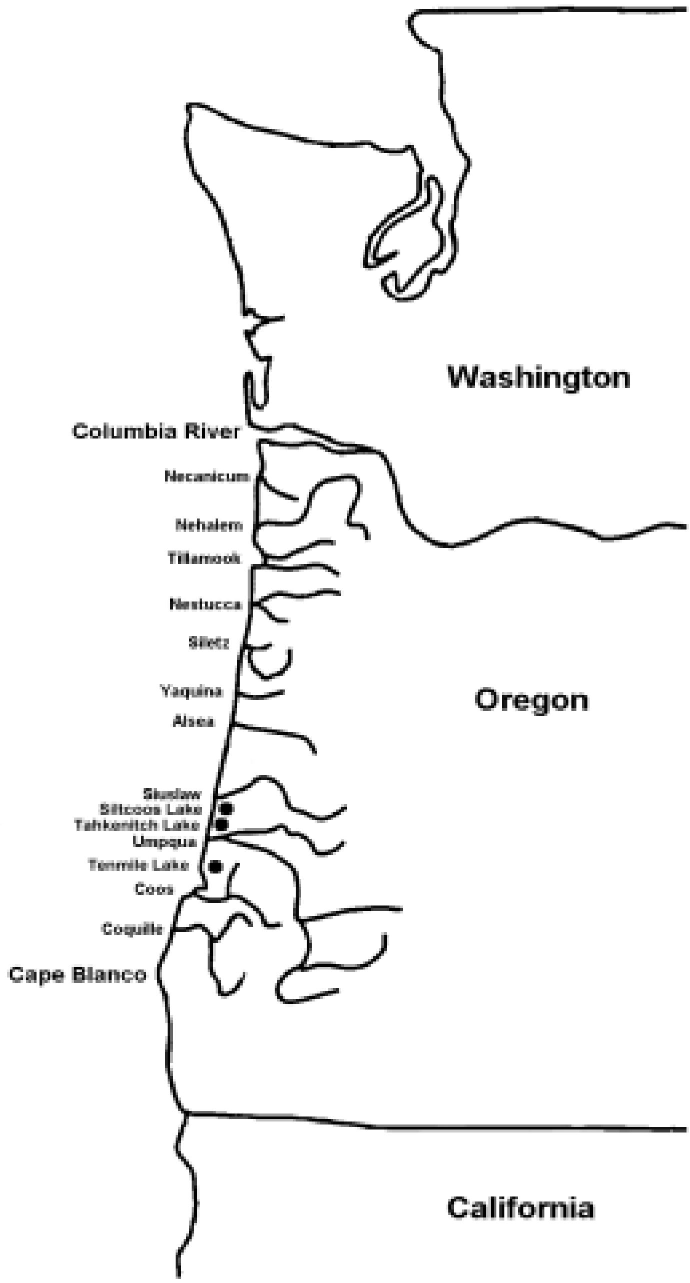
Hatchery measures

Of the proposed hatchery measures, substantial reductions in smolt releases were thought to have the most predictable benefit for natural populations; all else being equal, fewer fish released should result in fewer genetic and ecological interactions with natural fish. Marking all hatchery fish should also help to resolve present uncertainties about the magnitude of these interactions. However, the BRT expressed concerns regarding some aspects of the proposed hatchery measures. The plan was vague on several key areas, including plans for incorporation of wild broodstock and how production would be distributed among facilities after 1997. One concern was that the recent and proposed reductions appear be largely motivated by economic constraints and the present inability to harvest fish if they were produced rather than by recognition of negative effects of stray hatchery fish on wild populations. Other concerns expressed by the BRT included no reductions in fry releases in many basins, substantially higher releases of smolts in the Yaquina River Basin (which by ODFW's own assessment has more high quality habitat than any other coastal basin), and no consideration of alternative culture methods that could be used to produce higher-quality hatchery smolts which may have less impact on wild fish. Another concern was the plan's lack of recognition that hatchery-wild interactions reduce genetic diversity among populations.

Previous BRT Conclusions

In 1997, the BRT concluded that, assuming that 1997 conditions continued into the future (and that proposed harvest and hatchery reforms were not implemented), this ESU was not at significant short-term risk of extinction, but that it was likely to become endangered in the foreseeable future. A minority felt that the ESU was not likely to become endangered. Of those members who concluded that this ESU was likely to become endangered, several expressed the opinion that it was near the border between this and a "not at risk" category. The BRT generally agreed that implementation of the harvest and hatchery proposals of the OCSRI would have a positive effect on the status of the ESU, but the BRT was about evenly split as to whether the effects would be substantial enough to move the ESU out of the "likely to become endangered" category. Some members felt that, in addition to the extinction buffer provided by the estimated 80,000 naturally produced spawners in 1996, the proposed reforms would promote higher escapements and alleviate genetic concerns so that the ESU would not be at significant risk of extinction or endangerment. Other members saw little reason to expect that the hatchery and harvest reforms by themselves would be effective in reducing what they viewed as the most serious threat to this ESU—declining recruits-per-spawner. If the severe declines in recruits-per-spawner of natural populations in this ESU were partly a reflection of continuing habitat degradation, then risks to this ESU might remain high even with full implementation of the hatchery and harvest reforms. While harvest and hatchery reforms may substantially reduce short-term risk of extinction, habitat protection and restoration were viewed as key to ensuring long-term survival of the ESU, especially under variable and unpredictable future climate conditions. The BRT therefore concluded that these measures would not be sufficient to alter the previous conclusion that the ESU is likely to become endangered in the foreseeable future.

Figure C.2.1.1. Map of Oregon and Washington coasts showing the 11 major river systems plus three coastal lakes that comprise the Oregon Coast Coho Salmon ESU



Listing status

The Oregon Coast ESU of coho salmon was listed as a Threatened Species on August 10, 1998. The ESU includes all naturally spawned populations of coho salmon in Oregon Coastal Streams south of the Columbia River and north of Cape Blanco (Figure C.2.1.1).

C.2.1.2 New Comments

Alsea Valley Alliance v. Evans

On 10 September 2001 Judge Michael R. Hogan, ruling in *Alsea Valley Alliance v. Evans* for the United States District Court for the District of Oregon, found that, for the Oregon Coast ESU, "NMFS's listing decision is arbitrary and capricious, because the Oregon Coast ESU includes both "hatchery spawned" and "naturally spawned" coho salmon, but the agency's listing decision arbitrarily excludes "hatchery spawned" coho. Consequently, the listing is unlawful." (161 F. Supp. 2d 1154, D. Oreg. 2001). The lawsuit was brought by the Alsea Alliance, partly in response to an action by ODFW to terminate a domesticated coho salmon broodstock at the Fall River Hatchery on the Alsea River.

The effect of the ruling was to delist the Oregon Coast ESU. An appeal by appellant intervenors in the *Alsea* case is pending before the U.S. Court of Appeals for the Ninth Circuit. On December 14, 2001 the Court stayed the District Court ruling pending final disposition of the appeal (*Alsea Valley Alliance v. Evans*, 9th Circuit appeal, No. 01-36071, December 14, 2001). This returned the status of the Oregon Coast ESU to "threatened" under the Endangered Species Act. NMFS is currently reviewing its listing policy with regard to hatchery and wild salmon.

Petition for listing

On 25 April 2002 Regional Administrator D. Robert Lohn received a petition to define and list the wild stocks of coho along the Oregon Coast as a threatened species, pursuant to the Endangered Species Act, 16, U.S.C. Sec. 1531 et seq. (2001) (ESA). The petitioners present recent scientific reports relating to the "behavioral, physiological, ecological, reproductive and evolutionary differences between the hatchery and wild stocks" of Oregon coast coho salmon. The petition was in response to the findings of *Alsea Valley Alliance v. Evans*. The petitioners consist of Trout Unlimited, Oregon Council of Trout Unlimited, Washington Council of Trout Unlimited, Oregon Trout, Washington Trout, Native Fish Society, Oregon Council of Fly Fishers, Pacific Coast Federation of Fisherman's Associations and the Institute for Fisheries Resources, Oregon Natural Resources Council, Save our Wild Salmon, Orange Ribbon Foundation, American Rivers, Audubon Society of Portland, National Wildlife Federation, and the Siskiyou Regional Education Project. The petitioners state that:

> "NMFS has previously made findings of the detrimental impact that the artificial production of Oregon coast coho have on wild stocks, including genetic impacts, disease transmission, predation, take for broodstock purposes, and competition (62 Fed. Reg. 24588, 24600 (NMFS 1997); Flagg et al. 2000). Furthermore, recent reports indicate that these impacts are not localized, but rather widespread in every basin in the Oregon coast where wild coho are present, based on the presence of hatchery coho in every stream system (ODFW 1995b; Jacobs et al 2001). Additionally, the fluctuations in the ocean conditions, and the changes in the ocean carrying capacity, may exacerbate the impacts in certain years (NWPPC 1999). Additional reports suggest that the

> impact of these hatchery programs is resulting in at least phenotypic differences (genetic and environmental) between coho, and is not limited to hatchery management practices alone, but due to other direct biological and environmental effects (IMST 2001; Flagg et al. 2000; Chilcote 2002)."

The petitioners cite substantial updated information on current abundance, historical abundance and carrying capacity, trends in abundance, natural and human influenced factors that cause variability in survival and abundance, possible threats to genetic integrity, and recent events such as the current El Niño, significant flood events in 1995-96 and 1998, and recently improved ocean conditions (Trout Unlimited 2002).

Independent multidisciplinary science team

Since the 1997 status review, the Oregon Plan for Salmon and Watersheds (formerly Oregon Coastal Salmon Restoration Initiative Conservation Plan) has developed into an extensive effort to recover threatened or endangered salmonid populations through a combination of grass-roots actions through watershed councils, refocusing effort and resources of fisheries and other state agencies, and convening a group of scientists to "advise the state on matters of science related to the Oregon Plan for Salmon and Watersheds" (IMST 2002b). This group of scientists consists of a seven-member team with "recognized expertise in fisheries artificial propagation, stream ecology, forestry, range, watershed and agricultural management" and is known as the Independent Multidisciplinary Science Team (IMST). The IMST has been responsible for a series of review documents on the science relating to recovery of Oregon coastal coho stocks. The first of these was a workshop of agency and university fisheries professionals convened to help in the discussion of "Defining and Evaluating Recovery of OCN Coho Salmon Stocks: Implications for Rebuilding Stocks under the Oregon Plan" (IMST 1999). Alternative recovery definitions are proposed and criteria for evaluating recovery are discussed.

Additional reports issued by this team germane to the deliberations of the Oregon coastal coho BRT include: "Conservation Hatcheries and Supplementation Strategies for Recovery of Wild Stocks of Salmonids: Report of a Workshop" (IMST 2000), and "The scientific basis for artificial propagation in the recovery of wild anadromous salmonids in Oregon" (IMST 2001), which analyzes the hatchery programs of ODFW, presents three substantial conclusions and puts forth a series of ten recommendations based on these conclusions. In addition, a comprehensive look at the "Recovery of Wild Salmonids in Western Oregon Lowlands" (IMST 2002a) provides an extensive analysis of five science questions relating to the importance of lowlands to the recovery of salmonids, with twenty-one recommendations relating to recommended actions by state agencies to contribute to the recovery of salmonids in lowland areas. They do not, however, present substantially new information that can shed light on the evaluation of risk to the Oregon coastal coho ESU.

Douglas County Board of Commissioners—The board submitted a report, "Viability of coho salmon populations on the Oregon and northern California coasts," submitted to NMFS Protected Resources Division on 12 April 2002 and prepared by S.P. Cramer and Associates, Inc. (Cramer and Ackerman 2002). This report analyzes information available for both the Oregon Coastal Coho Salmon ESU and the SONCC ESU in several areas: trends in abundance and distribution, trends in survival, freshwater habitat condition, potential hatchery-wild interactions, changes in harvest regulation, and extinction risk modeling. Few of the data presented in the report are new, but independent analyses focus on unique aspects of the data. They cite changes in fishery management, increasing spawning escapements, reduced hatchery releases, habitat restoration, and evidence of successful rearing of fry outmigrants throughout the Oregon Coast. While the report reached no conclusions regarding overall status of the ESU, the Board cites the report in concluding that coho salmon populations in this ESU are “strongly viable.”

C.2.1.3 New Data and Update Analyses

Population abundance

For the Oregon Coast ESU, the BRT has received updated estimates of total natural spawner abundance based on stratified random survey (SRS) techniques, broken down by ODFW's Monitoring Areas (MAs), for 11 major river basins, and for the coastal lakes system (Steve Jacobs, Oregon Department of Fish and Wildlife, 28655 Hwy 34, Corvallis, Oregon 97333, pers. commun. Nov. 14, 2002) (ODFW’s Monitoring Areas are similar, but not identical to, the GCGs that were the population units in the 1997 update). These data are for the return years 1990-2002 and are presented in Table C.2.1.1 (for consistency with the previous status review for this ESU abundance and trend analysis in this update are expressed in terms of naturally-produced fish rather than the standard of naturally spawning fish used in other status review updates). Total recent average (3-year geometric mean) spawner abundance for this ESU is estimated at about 140,600, up from 5-year geometric mean of 52,000 in the 1997 update and also higher than the estimate at the time of the status review. In 2001 the ocean run size was estimated to be about 178,000; this corresponds to one-tenth of ocean run sizes estimated in the late 1800s and early 1900s, and only about one-third of those in the 1950s (ODFW 1995a). In 2002 the ocean-run size increased to 304,500 – fourth highest since 1970 and perhaps 25% of historical abundance. Present abundance is more evenly distributed within the ESU than it was in 1997. Escapement in the relatively small Mid/South Coast MA had been the strongest in the ESU until 2001. In 2002 escapements in the Mid/South were down about 25% while the North and Mid Coast MAs showed strong gains. The Umpqua MA is up by a factor of 4 since 1996. (Table C.2.1.1).

We have updated ocean exploitation estimates based on: Oregon Productivity Index (OPI) estimated catch and escapement based on SRS methods (“OPI-SRS”) for 1970-1993, post-season results of the Coho Fishery Regulation Assessment Model (“FRAM”) for 1994-2001, and the pre-season FRAM estimate for 2002 (OPI-SRS and FRAM from PFMC 2002). The ODFW Standard Index spawner escapement estimates were discontinued in 1999 and data from 1970-1989 were standardized to the SRS data. All analyses were done using this updated time series. Exploitation rates are based on ocean catch and incidental mortality plus escapement. Recruits are calculated as spawners divided by 1 minus the ocean exploitation rate. A major assumption is that progeny of natural spawners are affected by fishing gear the same as hatchery fish, so that ocean mortalities are in the same proportion as escapement. Freshwater harvest and mortality is not directly assessed, but is conventionally considered to be 10% of ocean escapement for retention fisheries and 1% for catch and release fisheries. The BRT also did not attempt to adjust trends for the contribution of stray hatchery fish; sufficient data for such an adjustment are not available for these populations.

We determined that the coded-wire-tag-based index (CWT) has become less useful since the implementation of coho non-retention fisheries in 1994. The CWT index depends on ocean recoveries of coded-wire tags and there are no tag recoveries in non-retention fisheries. Non-catch mortalities (hook-and-release, drop-off, illegal retention) are either estimated in the coho FRAM or estimated externally and input directly in the model.

We used escapement estimates provided by ODFW (Table C.2.1.1) (Steve Jacobs, Oregon Department of Fish and Wildlife, 28655 Hwy 34, Corvallis, Oregon 97333, pers. commun. Nov. 14, 2002). The SRS escapement data indicate that, on an ESU-wide basis, spawning escapement reached a 30-year high in 2001 and continued to climb in 2002 (Figures C.2.1.2 and C.2.1.3). This high escapement is due to a combination of improved marine survival and sharply curtailed ocean fisheries. When looked at on a finer geographic scale, the North Coast has responded well after a very weak period through 1999. The Mid Coast was mixed in 2001 with strong increases in some streams but continued very poor escapement in others. Substantial increases in 2002 made it the strongest area on the coast. The Mid-South coast rebounded in 2002 after a 4-year drop (Table C.2.1.1).

Three-year statistics (geometric mean, arithmetic mean, minimum and maximum spawners and recruits) in individual river basins are strongly affected by the recent two years of high marine survival (Table C.2.1.2). Abundance has grown exponentially in the past three years, so Arithmetic means are uniformly higher than geometric means. The minimum and maximum abundances show that, with a few exceptions, abundances in individual basins have increased about 10-fold in the past three years. Abundance in the Nehalem ranged only from 14285 to 22310 indicating this system may have been near capacity before survival improved. On the other hand, the Yaquina grew from 647 to 25039 – nearly a 40-fold increase. Statistics for the combined systems (Table C.2.1.3) are more stable, but indicate an overall four-fold increase in spawners over the past three years.

Table C.2.1.1. Numbers of natural-origin spawners in the Oregon Coast Coho ESU estimated from ODFW Stratified Random Surveys, 1990—2002 return years. Results are sub-totaled by ODFW Monitoring Area, rivers, lakes, and coast-wide. Monitoring Area totals from 1999-2002 are estimated by Monitoring Area and may differ from the sums of the individual rivers.

Management Area:	Return Year												
Location	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
North Coast:													
Necanicum and													
Elk Creek	191	1,135	185	941	408	211	768	253	946	728	474	5,247	2,710
Nehalem	1,552	3,975	1,268	2,265	2,007	1,463	1,057	1,173	1,190	3,713	14,285	22,310	20,654
Tillamook Bay	265	3,000	261	860	652	289	661	388	271	2,175	1,983	1,883	16,488
Nestucca	189	728	684	401	313	1,811	519	271	169	2,201	1,171	3,940	12,334
Sand Lake and													
Neskowin Cr	0	240	24	41	77	108	275	61	0	47	0	71	16
Miscellaneous	0	204	0	0	0	0	0	0	0	0	0	0	0
North Coast Total	2,197	9,281	2,423	4,509	3,457	3,881	3,280	2,147	2,576	8,842	17,898	33,667	52,202
Mid-North:													
Salmon	385	39	28	364	107	212	271	237	8	175	0	310	1,237
Siletz	441	984	2,447	400	1,200	607	763	336	394	706	3,553	1,437	2,369
Yaquina	381	380	633	549	2,448	5,668	5,127	384	365	2,588	647	3,039	25,039
Beaver Creek	23	0	756	500	1,259	0	1,340	425	1,041	3,366	738	5,274	7,596
Alsea	1,189	1,561	7,029	1,071	1,279	681	1,637	680	213	2,050	2,465	3,339	5,767
Yachats	280	28	337	287	67	117	176	99	102	150	79	52	1,661
Siuslaw	2,685	3,740	3,440	4,428	3,205	6,089	7,625	668	1,089	2,724	6,767	11,024	57,125
Miscellaneous	207	0	700	180	251	231	1,188	13	71	0	12	764	3,315
Mid-North Total	5,592	6,732	15,371	7,779	9,815	13,605	18,127	2,843	3,283	11,442	14,181	25,528	104,111

Table C.2.1.1 (continued).

Umpqua:													
Lower Umpqua and Smith	589	1,316	1,759	4,804	1,689	6,803	4,904	935	5,118	2,323	3,696	8,850	25,939
Umpqua	455	0	192	1,431	1,240	352	339	397	444	1,289	2,774	8,177	7,972
Elk Creek and Calapooya Creek	185	0	0	0	708	2,315	1,709	196	379	434	1,864	2,581	1,477
South Umpqua	2,508	2,284	0	2,415	579	755	1,685	512	678	1,219	479	6,482	1,419
Cow Creek	0	0	201	661	269	1,124	1,112	193	1,807	1,234	1,582	6,661	5,608
Umpqua Total	3,737	3,600	2,152	9,311	4,485	11,348	9,749	2,233	8,426	6,466	10,468	34,041	42,413
Mid-South:													
Coos Bay and Big Creek	2,273	3,813	16,545	15,284	14,685	10,351	12,128	1,127	3,167	4,945	5,386	43,301	35,005
Coquille	2,712	5,651	2,115	7,384	5,035	2,116	16,169	5,720	2,466	3,001	6,130	13,310	8,488
Miscellaneous	0	1	2	3	4	5	6	7	8	9	10	11	11
Mid-SouthTotal	4,985	9,465	18,662	22,671	19,724	12,472	28,303	6,854	5,641	7,946	11,516	56,611	43,512
Coast-wide Rivers	16,512	29,078	38,607	44,270	37,481	41,306	59,459	14,076	19,926	34,696	54,063	149,847	242,238
Lakes	4,394	7,251	1,986	10,145	5,842	11,216	13,494	8,603	11,108	12,711	12,747	19,669	22,097
Coast-wide Total	20,906	36,329	40,593	54,415	43,323	52,522	72,953	22,679	31,034	47,407	66,810	169,516	264,335

Table C.2.1.2. Three-year statistics and 13-year trends for 11 major river basins in the Oregon Coast ESU. Spawners are natural-origin spawners only. Recruits are natural-origin adults before ocean harvest.

	Spawners						Recruits					
	3 year mean		3 year range		13 year		3 year mean		3 year range		13 year	
Basin	Geometric	Arithmetic	Minimum	Maximum	Trend	SE	Geometric	Arithmetic	Minimum	Maximum	Trend	SE
Necanicum	1889	2810	474	5247	1.169	0.860	2096	3,101	522	5,667	1.076	0.941
Nehalem	18741	19083	14285	22310	1.206	0.889	20799	21,188	15,728	24,097	1.110	1.042
Tillamook	3949	6785	1883	16488	1.191	1.084	4382	7,723	2,034	18,952	1.096	1.191
Nestucca	3846	5815	1171	12334	1.230	1.015	4269	6,574	1,289	14,177	1.132	1.133
Siletz	2295	2453	1437	3553	1.070	0.760	2547	2,729	1,552	3,912	0.985	0.847
Yaquina	3665	9575	647	25039	1.204	1.205	4067	10,925	712	28,780	1.108	1.204
Alsea	3621	3857	2465	5767	1.042	0.960	4018	4,316	2,714	6,629	0.959	1.089
Siuslaw	16213	24972	6767	57125	1.120	1.037	17993	28,339	7,450	65,661	1.031	1.150
Umpqua	24351	28520	10395	42415	1.182	0.662	27025	31,857	11,445	48,753	1.088	0.764
Coos	20136	27897	5386	43301	1.088	1.066	22346	30,978	5,930	46,769	1.002	1.098
Coquille	8847	9309	6130	13310	1.070	0.649	9819	10,294	6,749	14,376	0.984	0.684

Table C.2.1.3. Three-year statistics and 33-year trends for Oregon Coast ESU rivers, lakes, and combined rivers and lakes. Spawners are natural-origin spawners only. Recruits are natural-origin adults before ocean harvest.

	Spawners						Recruits					
	3 year mean		3 year range		33 year		3 year mean		3 year range		33 year	
	Geometric	Arithmetic	Minimum	Maximum	Minimum	Maximum	Geometric	Arithmetic	Minimum	Maximum	Trend	SE
Rivers	122718	147933	50500	242200	1.017	0.600	136291	165933	55600	279000	0.950	0.575
Lakes	16189	16635	12747	22097	1.013	0.735	17966	18567	14034	25399	0.946	0.592
Combined	140568	164569	63247	264297	1.016	0.566	156105	184500	69634	304399	0.949	0.520

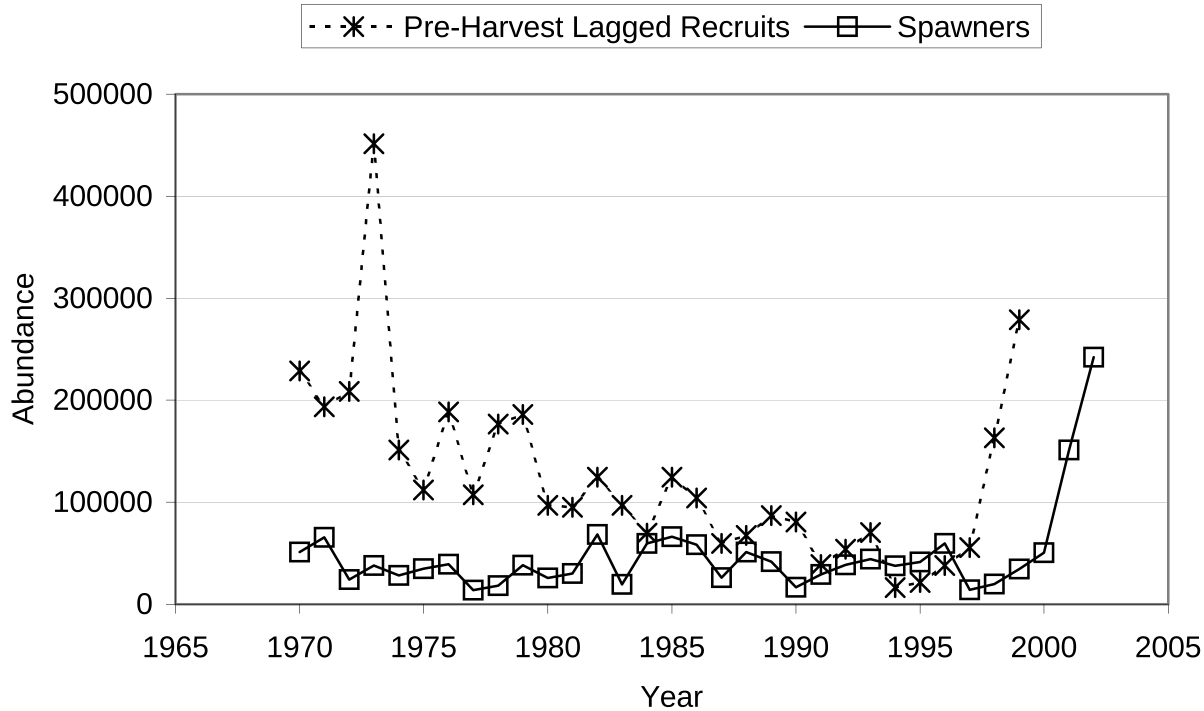


Figure C.2.1.2. Time series of spawners and pre-harvest recruits, by broodyear, for rivers in the Oregon Coast coho salmon ESU.

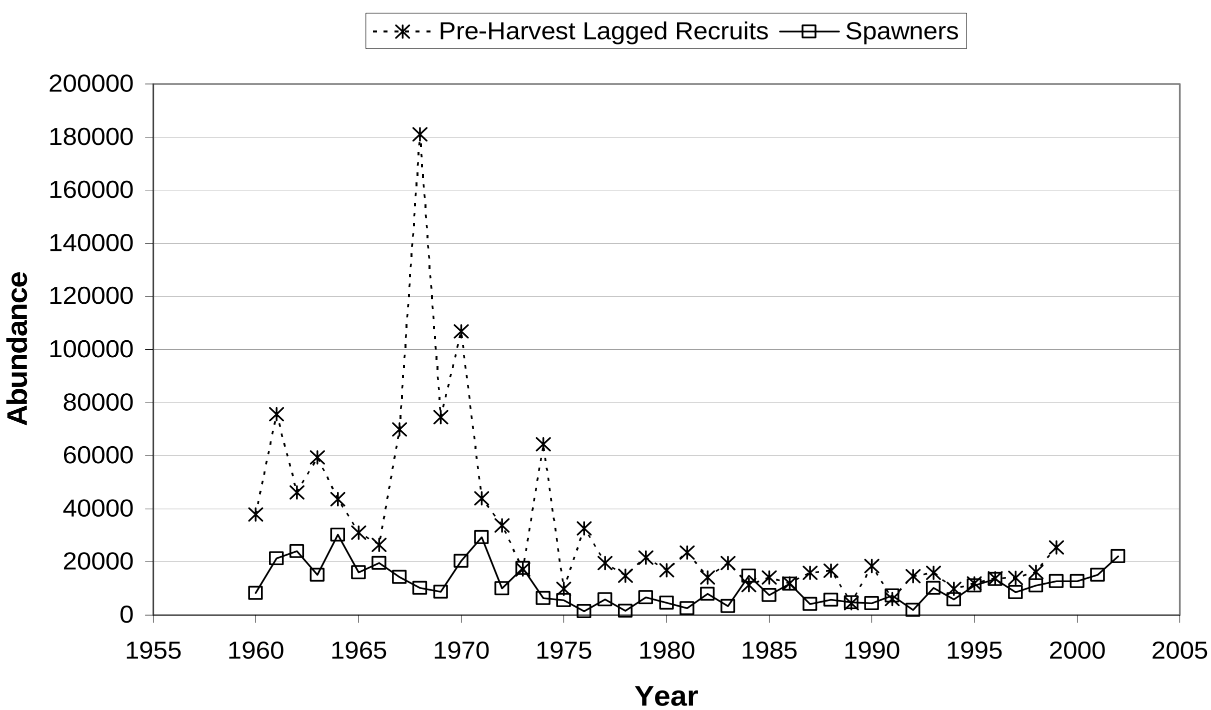


Figure C.2.1.3. Time series of spawners and pre-harvest recruits, by broodyear, for lakes in the Oregon Coast coho salmon ESU.

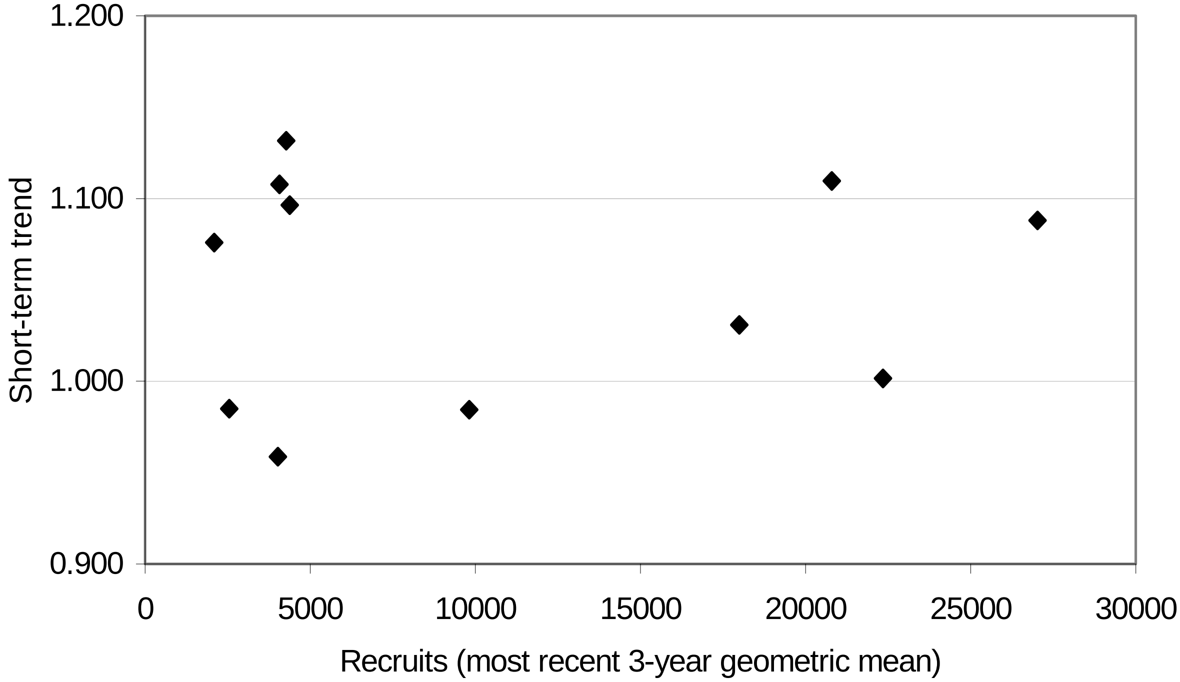


Figure C.2.1.4. Short-term (13-year, 1990-2002) trends in spawners and recruits vs. the recent 3-year geometric mean abundance plotted for 11 major river populations.

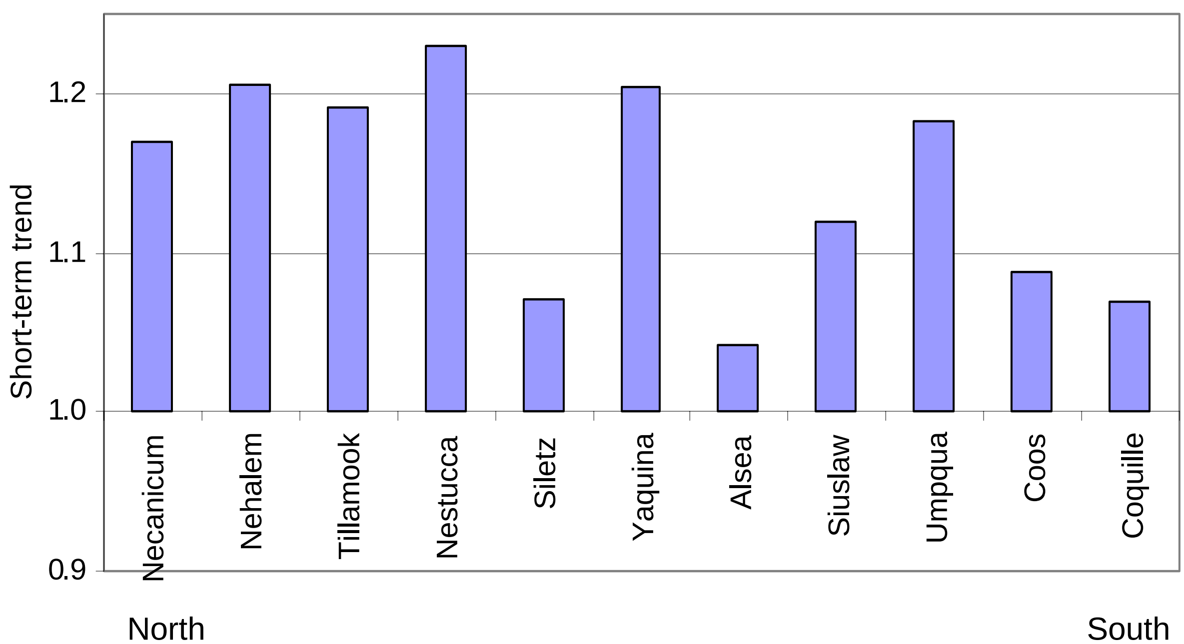


Figure C.2.1.5. Short-term (13-year, 1990-2002) trends in spawner abundance for 11 major river basins in the Oregon Coast coho salmon ESU. Basins are ordered from north to south.

In the return years 1997-1999 (broodyears 1994-1996), and for the first time on record (since 1950), recruits failed to replace the parental spawners: a recruitment failure occurred in all three brood cycles, even before accounting for harvest-related mortalities (Figure C.2.1.2). Since 1999, improving marine survival and higher rainfall are thought to be the factors contributing to an upswing in wild recruitment. Fishery recruitment for 2002 was up over four-fold from 2000 with about 304,000 recruits, but below the 30-year high of 450,000 observed in 1973. Given current habitat conditions OCN coho are thought to require an overall marine survival rate of 0.03 to achieve a spawner:recruit ratio of 1:1 in the best quality habitat (Nickelson and Lawson 1998). Less productive habitats require higher marine survivals to sustain populations. Based on OPI hatchery survival rates marine survival after exploitation exceeded 0.03 only in the year 2001. Assuming natural spawners survive at twice the hatchery rate there were seven of thirteen years since 1990 with marine survivals after exploitation high enough to sustain the strongest populations. Increases in recruits and spawners (Figures C.2.1.2 and C.2.1.3) reflect improved marine survival for the 2000 and 2001 smolt years. It is far from certain that these favorable marine conditions will continue and, with the current freshwater habitat conditions, the ability of OCN coho to survive another prolonged period of poor marine survival remains in doubt.

Growth rates/productivity

Trend analyses were performed on short-term and long-term time series of spawner abundance and pre-harvest recruit abundance calculated as described above. Short-term trends were based on stratified-random-sampling (SRS) estimates of abundance in 11 major river basins considered to be the principal populations in this ESU. Short-term trends used data from 1990-2002 return years. Long-term trends were estimated separately for the aggregated coastal rivers (including several small systems outside the 11 major river basins) and for the coastal lakes. The river trends were based on data calibrated to the SRS time series from 1970-2002. The lake trends were based on the historical time series of lakes abundance from 1970-2002.

Thirteen-year trends of spawner abundance for 11 major river systems are presented in Table 2.1.2 and illustrated in Figures C.2.1.4 and C.2.1.5. Spawner trends have been positive in all 11 basins, with the biggest increases (> 10% per year) on the north coast (Necanicum, Nehalem, Tillamook, Nestucca), mid-coast (Yaquina, Siuslaw) and the Umpqua, and with smaller increases on the central (Siletz, Siuslaw) and south (Coos, Coquille) coast. The Alsea showed the weakest trend and was > 1 as of the 2002 spawning returns (Figure C.2.1.5).

Thirteen-year trends in pre-harvest recruits (Figures C.2.1.4 and C.2.1.6) show a less favorable picture. Necanicum, Nehalem, Tillamook, Nestucca, Yaquina, and Umpqua all showed positive trends of about 8 -13% per year. Siletz, Alsea, and Coquille showed declines ranging of 1 - 4% per year. Upward trends in the Tillamook, Siuslaw, and Coos hinge on the high 2002 escapements. The most recent 3-year geometric mean abundance showed little relationship to trend (Figure C.2.1.4).

Long-term (33-year) trends in spawner abundance for both the lakes and rivers have been relatively flat (Table C.2.1.3, Figure C.2.1.7), with lakes increasing about 2% per year and rivers increasing about 1% per year. In both the lakes and rivers long-term trends in recruits have declined about 5% per year since 1970. For the ESU as a whole, spawners and recruits have declined at a 5% rate over the past 33 years.

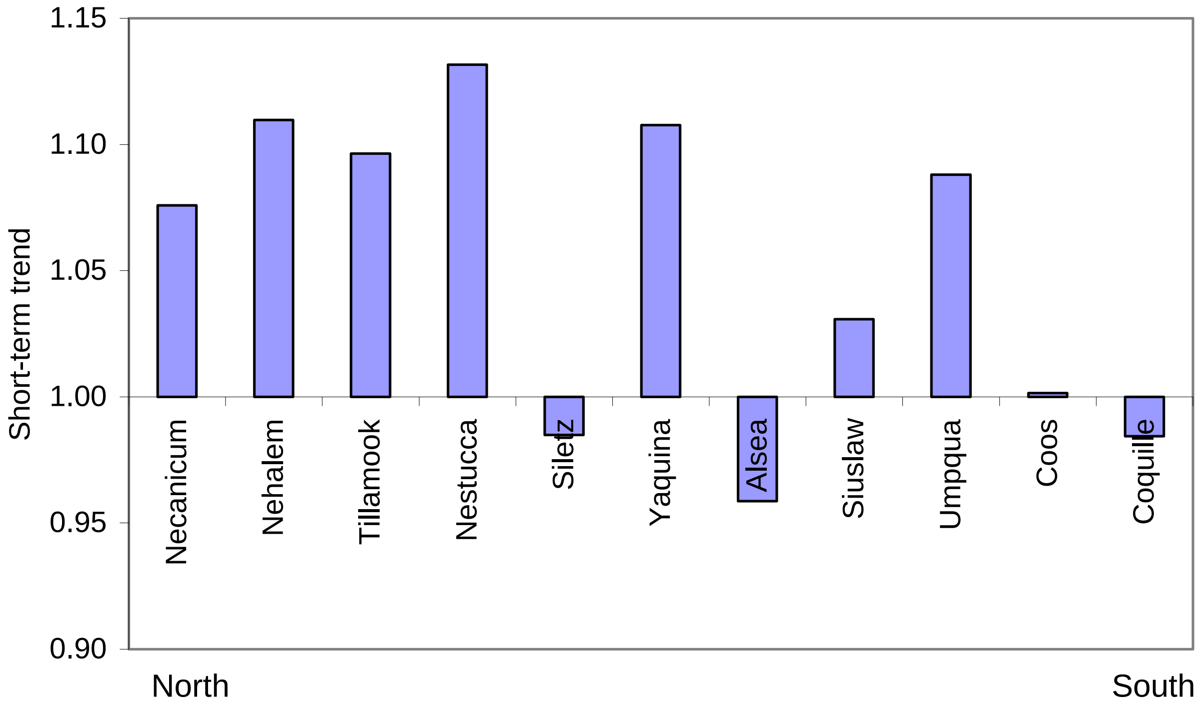


Figure C.2.1.6. Short-term (13-year, 1990-2002) trends in recruit abundance for 11 major river basins in the Oregon Coast coho salmon ESU. Basins are ordered from north to south.

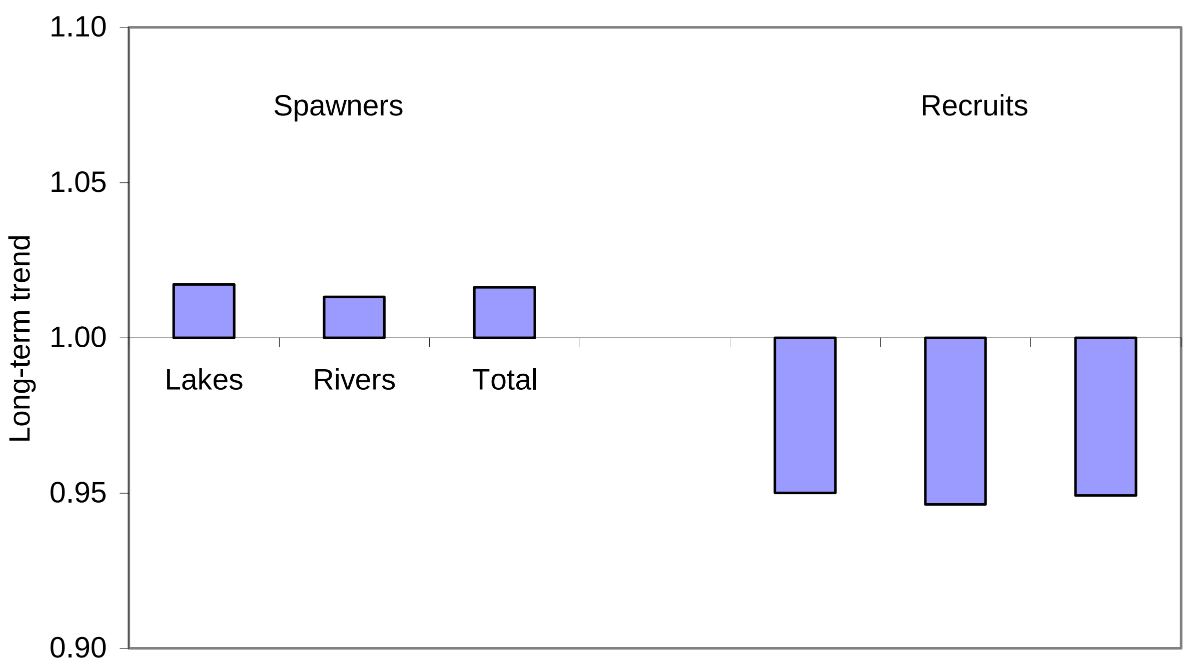


Figure C.2.1.7. Long-term trends (33 years, 1970 – 2002) for spawners and recruits in coastal lakes (Lakes), river basins (Rivers), and total OCN (Total) in the Oregon Coast coho salmon ESU.

Population spatial structure

We have very limited direct information about the spatial structure of these populations. Recent analyses (Nickelson and Lawson 1998, Nickelson 2001) have assumed that spawners from major river basins are largely isolated and that each basin comprises at least one population. The Umpqua River is large and diverse enough to hold several populations, but for the purposes of this analysis was considered as one. The three coastal lakes, Siltcoos, Tahkenitch, and Tenmile, are considered to be a single population, but may actually be separate. Genetic analyses are being conducted to resolve these questions, but results were not available at the time of this review. This is a change from the Status Review Update in 1997 (Schiewe 1997) when the coast was considered to consist of four populations, called "Gene Conservation Groups." Three of these groups (North/Mid Coast, Mid/South Coast, and Umpqua) were in the Oregon Coast ESU and the fourth (South Coast) was in the Southern Oregon/Northern California ESU.

Population diversity

New information on population diversity is anecdotal. With extremely low escapements in recent years many small systems have shown local extirpations. For example, Cummins Creek, on the central coast, had zero spawners in 1998 (Steve Johnson, Oregon Department of Fish and Wildlife, 2040 Marine Science Drive, Newport, Oregon , pers. commun. January 15, 2003), indicating the loss of a brood cycle. These systems are apt to be repopulated by stray spawners if abundances increase. Whether these events represent loss of genetic diversity or are indications of normal metapopulation function is not known.

Harvest impacts

Historical harvest rates on OPI area coho salmon were in the range of 60% to 90% from the 1960s into the 1980s. Modest harvest reductions were achieved in the late 1980s, but rates remained high until a crisis was perceived and most directed coho salmon harvest was prohibited in 1994. Subsequent fisheries have been severely restricted and most reported mortalities are estimates of indirect (non-catch) mortality in chinook fisheries and selective fisheries for marked (hatchery) coho. Estimates of these indirect mortalities are somewhat speculative and there is a risk of substantial underestimation.

Amendment 13—The Pacific Fishery Management Council adopted Amendment 13 (PFMC 1998) to their Salmon Fishery Management Plan in 1998. This amendment was developed as part of the Oregon Plan for Salmon and Watersheds (formerly OCSRI). It specified an exploitation rate harvest management regime with rates for OCN dependent on marine survival (as indexed by hatchery jack/smolt ratios) and parental and grand-parental spawning escapements. Exploitation rates ranged from 13% to a maximum of 35%. In 2000, Amendment 13 was reviewed, and the harvest rate matrix modified to include a 0-8% category under conditions of extremely poor marine survival as had been observed in the late 1990. At the same time, the maximum exploitation rate was increased to 45%. Exploitation rates were calculated to allow a doubling of spawners under conditions of moderate to good ocean survival.

Risk assessment was conducted for Amendment 13 (PFMC 1998) and the 2000 Amendment 13 Review (PFMC 2000) using the Nickelson/Lawson coho salmon habitat-based life-cycle model (Nickelson and Lawson 1998). The models were augmented to include a simulation of the fishery management process, including errors in spawner assessment, prediction, and harvest management. In general, the exploitation-rate management with a 35% cap showed a lower risk of pseudo-extinction than managing for an escapement goal of 200,000 spawners, but higher risk than a zero-harvest scenario. Starting from the very low escapements of 1994, basins on the North Coast had higher extinction risks than those on the Mid-North and Mid-South coasts.

Mark-selective fisheries—Beginning in 1998 most adult hatchery-origin coho salmon in the OPI area were marked with an adipose fin clip. This allowed the implementation of mark-selective fisheries, with legal retention only of marked fish. Unmarked fish were to be released unharmed. Recreational mark-selective fisheries have been conducted on the Oregon coast in each year since 1998, with quotas ranging from 13,000 to 24,000 marked fish. Commercial troll fisheries targeting chinook salmon were also operating.

Both fisheries catch and release coho salmon, resulting in incidental mortalities. In addition, some coho encounter the gear but escape or are eaten by predators – so called "drop-offs." Estimates of non-catch mortalities from hook and release and drop-off are difficult because they are, by their nature, unobserved. Field studies in the 1990s (NRC 1996) and a literature review and meta-analysis resulted in the adoption, by the PFMC, of hooking mortality rates of 13% for recreational fisheries and 24% for commercial fisheries. In addition, dropoff mortalities were assumed to equal 5% of the number of fish brought to the boat. Based on these mortality rates the PFMC uses a coho Fisheries Regulation Assessment Model (FRAM) to estimate noncatch mortalities in Council-managed fisheries. Post-season estimates of OCN exploitation rates based on FRAM modeling have ranged from 0.07 to 0.12 since the cessation on directed coho salmon fishing in 1994 (Table C.2.1.4). There is concern that these rates may be underestimates, and that actual mortalities may be greater. It is difficult to assess the risk to these stocks resulting from harvest at these levels.

Table C.2.1.4. OPI area hatchery marine survival, Oregon Coastal hatchery adult returns per smolt, and OPI area exploitation rate on unmarked coho salmon. All values are lagged to adult return year.

Year	OPI Hatchery Adults per Smolt	Coastal Hatchery Adults per Smolt	OPI Area Unmarked Exploitation Rate	OPI Marine Survival after Exploitation
1990	0.020	0.003	0.72	0.006
1991	0.050	0.007	0.57	0.022
1992	0.026	0.004	0.56	0.011
1993	0.011	0.003	0.45	0.006
1994	0.018	0.005	0.03	0.017
1995	0.024	0.005	0.23	0.018
1996	0.021	0.006	0.15	0.018
1997	0.006	0.005	0.13	0.005
1998	0.008	0.005	0.07	0.007
1999	0.011	0.008	0.08	0.010

2000	0.023	0.014	0.09	0.021
2001	0.050	0.044	0.07	0.046
2002	0.026	0.033	0.12*	0.023

*preseason estimate

Despite these uncertainties there is no doubt that harvest-related mortalities have been reduced substantially over the past decade. This reduction is reflected in positive short-term trends in spawner escapements (Figure C.2.1.5) despite continued downward trends in pre-harvest recruits for six of 11 major river basins (Figure C.2.1.6). Harvest management has succeeded in maintaining spawner abundance in the face of a continuing downward trend in productivity of these stocks. Further harvest reductions can have little effect on spawning escapements. Future remedies must be found outside of harvest management until the decline of productivity is reversed.

Habitat condition

Freshwater—The Oregon Plan for Salmon and Watersheds (Oregon Plan 1997) is the most ambitious and far-reaching program to improve watersheds and recover salmon runs in the Pacific Northwest. It is a voluntary program focused on building community involvement, habitat restoration, and monitoring. All State agencies with activities affecting watersheds are required to evaluate their operations with respect to salmon impacts and report on actions taken to reduce these impacts to the Governor on a regular basis. The original Coastal Salmon Restoration Initiative was written in 1997, so the Plan has been in operation for about 5 years. As a result of the plan, watershed councils across the State have produced watershed assessments of limiting factors for anadromous salmonids on both public and private land. The State of Oregon has dedicated about $20 million/year to implement restoration projects and is developing a system to link project development with whole-watershed assessments. The Oregon Department of Environmental Quality and the Oregon Department of Agriculture are implementing regulatory mechanisms to reduce non-point-source pollution. If these efforts are successful Oregon could see a widespread improvement in water quality. There is room for improvement in the reporting of watershed assessment results and limiting factors, and identification of actions to be taken or progress made in addressing these limiting factors. While this is a significant recovery effort in the Pacific Northwest, and an extensive, coordinated monitoring program is in place, measurable results of the program will take years or decades to materialize.

Marine—The regime shift in 1976 was the beginning of an extended period of poor marine survival for coho salmon in Oregon. Conditions worsened in the 1990s, and OPI hatchery survival reached a low of 0.006 adults per smolt in 1997 (1996 ocean entry, Table C.2.1.4). Coastal hatcheries appear to have fared even worse, although adult counts at these facilities are often incomplete, biasing these estimates low. Following an apparent shift to a more productive climate regime in 1998 marine survival has started to improve, reaching 0.05 for adults returning in 2001 (Table C.2.1.4). The Pacific Decadal Oscillation (PDO) had been in a cold, productive phase for about 4 years and in August reversed indicating a warm, unproductive period. This reversal may be short-lived; the PDO historically has show a 20-60 year cycle. However, "the rising influence of global warming should throw up a big caution sign to us when trying to use past decadal patterns as predictive models for the future" (Nathan J. Mantua, School of Marine

Affairs/Joint Institute for the Study of Atmospheric and Oceanic Climate Impacts Group, University of Washington, Seattle, pers. commun. January 7, 2003).

Table C.2.1.5. Millions of smolts released, adult returns, and number of operating hatcheries on the Oregon Coast from 1990 to 2002. [1]Excludes three small hatcheries: Elk River, Cedar Creek, and Eel Lake. [2]An additional 5.4 million smolts were released from private facilities in 1990.

Year	Smolts Released (millions)	Adult Returns to Hatchery	Number of Hatcheries[1]
1990[2]	5.70	15,489	6
1991	5.30	39,555	6
1992	6.20	23,307	6
1993	4.33	20,209	6
1994	5.02	23,435	6
1995	3.71	25,173	6
1996	3.28	23,422	7
1997	2.92	17,776	7
1998	1.66	15,287	7
1999	1.06	13,347	6
2000	0.86	14,984	5
2001	0.93	38,149	5
2002	0.98	30,862	5

A long-term understanding of the prospects for OCN coho can be constructed from a simple conceptual model incorporating a trend in habitat quality and cyclical ocean survival (Figure C.2.1.8, Lawson 1993). Short-term increases in abundance driven by marine survival cycles can mask longer-term downward trends resulting from freshwater habitat degradation (as in Figure C.2.1.8) or longer-term trends in marine survival that may be a consequence of global climate change. Decreases in harvest rates (C in Figure C.2.1.8) can increase escapements and delay ultimate extinction (D in Figure C.2.1.8). Harvest rates have been reduced to the point where no further meaningful reductions are possible. The current upswing in marine survival is a good thing for OCN coho, but will only provide a temporary respite unless other downward trends are reversed.

C.2.1.4. New Hatchery Information

Interactions between hatchery and wild fish are generally considered to have negative outcomes for the wild fish. A growing body of literature documents reduced spawning success, freshwater survival and production of wild fish when hatchery fish are present (IMST 2001, Einum and Fleming 2001, Flagg et al. 2000, Independent Scientific Group 1996, National Research Council 1996, Flagg and Nash 1999, Chilcote 2002). Additional negative interactions are associated with mark-selective fisheries directed at hatchery coho salmon in the ocean. In the past 12 years there have been closures of some Oregon coastal hatchery facilities, reduction in numbers of smolts released from the remaining facilities, and efforts to

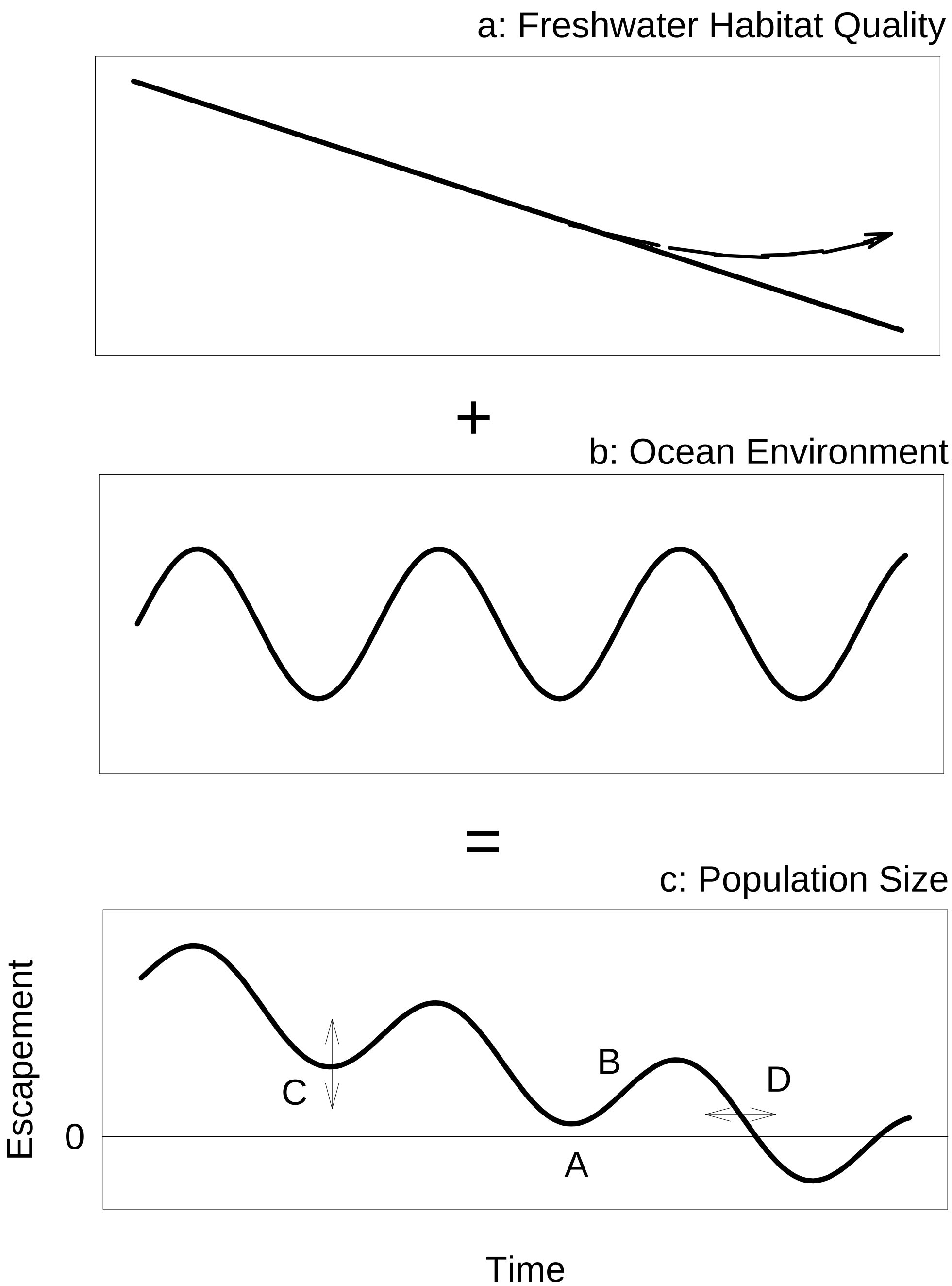


Figure C.2.1.8. Conceptual model of effects of declining habitat quality and cyclic changes in ocean productivity on the abundance of Oregon's coastal natural coho salmon. a: trajectory over time of habitat quality. Dotted line represents possible effects of habitat restoration projects. b: generalized time series of ocean productivity. c: sum of top two panels. Labeled points on c: A = situation in the mid 1990s, B = current situation, C = change in escapement from increasing or decreasing harvest, and D = change in time of extinction from increasing or decreasing harvest. Figure from Lawson 1993 include more native broodstock. In principle, these changes should somewhat reduce risks to naturally spawning coho on the Oregon coast.

Starting in 1999 most adult coho salmon of hatchery origin were marked with an adipose fin clip. This has enabled the introduction of mark-selective fisheries for hatchery (fin-clipped) coho salmon. An additional benefit is better accounting of hatchery fish spawning in the wild.

Hatchery smolts released are reported in Table C.2.1.5. Numbers have dropped from a high of 6.2 million in 1992 to 0.93 million in 2001. Over that time period several small hatcheries have closed or stopped releasing coho. For three years (1995 – 1997) coho smolts were released from the acclimation facility on Yaquina Bay. In 1999 Fall Creek Hatchery on the Alsea River stopped releasing coho salmon smolts. The percentage of hatchery-origin spawners on natural spawning grounds has also decreased (Figure C.2.1.9, Table C.2.1.6, Table C.2.1.7). Throughout most of the 1990s, the percentage of natural spawners that were of hatchery origin exceeded 10% in over half of Oregon coast basins and exceeded 70% in three. By contrast, in the most recent three years the proportion of hatchery-origin spawners has generally been much lower (Table C.2.1.6, Table C.2.1.7). The decrease is most notable in North Coast systems that had up to 70% hatchery spawners in the early 1990s and have averaged below 5% since 1999. Both the Tillamook and Umpqua basins continue to show elevated numbers of hatchery-origin spawners in most years, and the Alsea River had 7% hatchery spawners in 2001 despite the closure of the Fall Creek Hatchery in that system.

Overall, the reduction in hatchery activity is expected to benefit wild runs. However, it may take several years before these benefits become apparent, depending on the mix of demographic and genetic effects on natural production. In the meantime, the future of the hatchery program is uncertain. On one hand, public opinion and a perceived short-term benefit may create pressure to increase hatchery activity despite the likely negative effects on wild runs. On the other hand, Oregon State budget problems may force additional hatchery closures. The Trask and Salmon River hatcheries were scheduled to be closed in 2001 but were given a last-minute reprieve by the Oregon Legislature.

Jacobs et al. (2000) discuss potential errors associated with the change in methodology used to determine the origin of natural spawners. Prior to 1998, hatchery or wild origin was determined primarily by scale analysis, while mass marking permitted the use of adipose fin clips beginning in 1998. In 1998 and 1999 both methods were used. Comparison of results from the two methodologies show that scales tend to indicate greater proportion of hatchery fish than fin clips, although there are limitations associated with both methodologies. The primary limitation of scale analysis is availability of adequate reference scales for naturally produced fish, while marking programs may not actually mark 100% of the fish as intended.

Estimates of hatchery fish contribution rates from scale analysis are complicated by the low sample sizes collected during the extremely low coho abundances in the 1990s. ODFW determined that acceptable estimates of hatchery contribution rates could not be made in cases where fewer than 10 scales were collected in a basin in a year. These were reported as zero percent hatchery fish even when hatchery scales were observed in the sample. Small sample zeros are not distinguishable from true zeros in Table C.2.1.7, resulting in an under reporting of hatchery contributions that we are unable to evaluate. Figure C.2.1.9 attempts to minimize this problem by aggregating data over the years 1992-1998, and probably presents a truer overall picture for that time period of general patterns in hatchery fish distribution in the ESU.

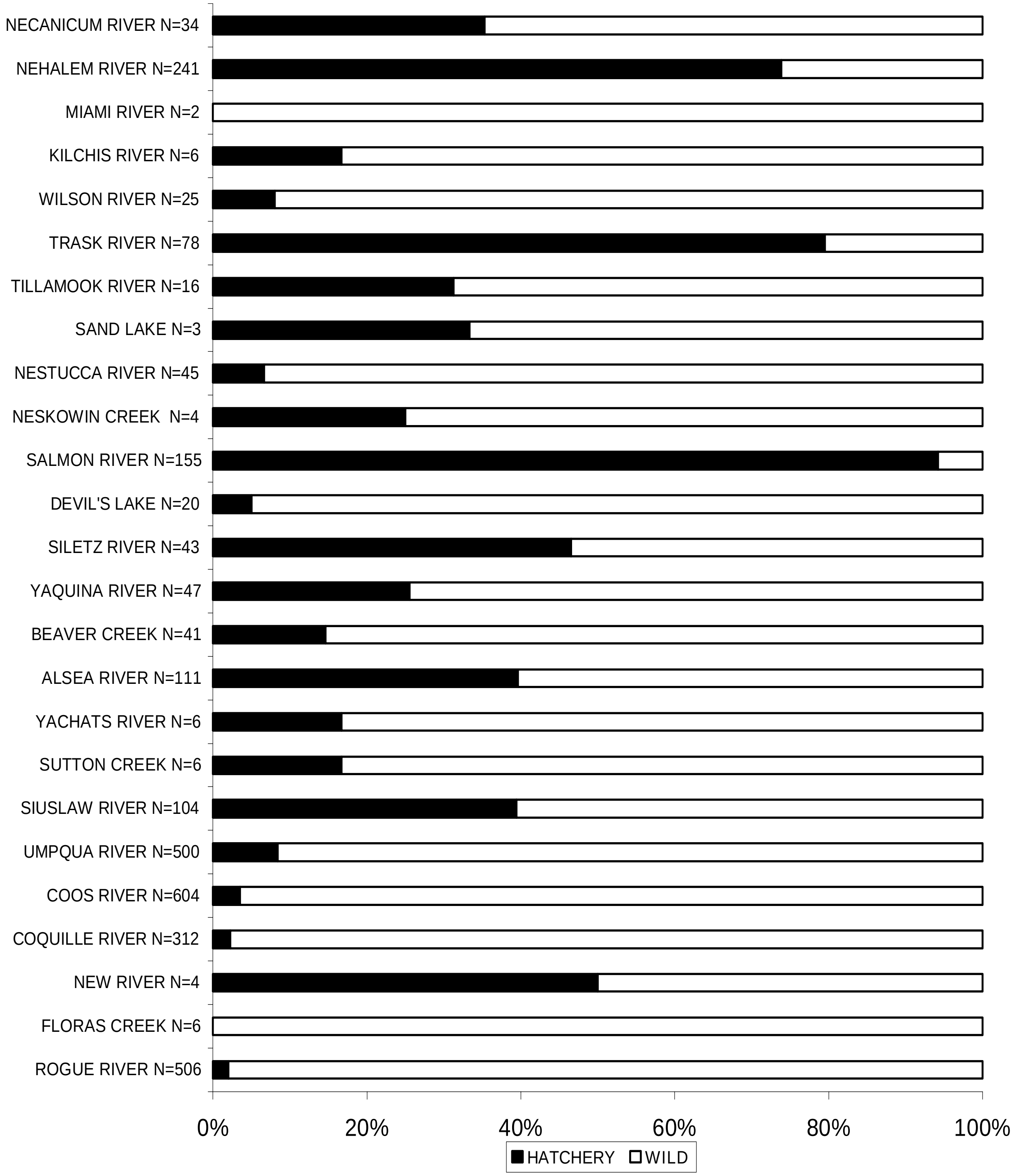


Figure C.2.1.9. Rearing origin of naturally spawning adult coho salmon in major coastal river basins over the 6-year period of 1992-98. Estimates derived from analysis of scales collected on random spawning surveys. Samples from the Rogue Basin are only from the most recent 3-year period (1996-98). Solid bars represent hatchery fish and open bars represent naturally produced fish. Reproduced from Jacobs et al. 2000.

Table C.2.1.6. Percent of natural spawning coho salmon of hatchery origin based on fin clips from carcasses (1998, 1999) or both carcasses and live fish (2000-2002). Hatchery percentages from 1998 and 1999 are adjusted by marked:unmarked ratios at nearest hatchery facility. Data from Jacobs et al. 2000, 2001, 2002, and Jacobs pers. comm. (4/9/03).

Major Basin	**1998**		**1999**		**2000**		**2001**		**2002**	
	n	**% H**	**n**	**% H**	**n**	**% H**	**n**	**% H**	**n**	**% H**
North Coast:										
Necanicum & Elk Creek	2	0.0	8	0.0			605	6.4	280	2.9
Nehalem[1]	22	26.0	14	0.0	1,995	0.5	2,735	2.0	2,535	6.2
Tillamook Bay	1	0.0	18	5.6	224	10.8	124	4.1	1,874	2.0
Nestucca	1	0.0	20	0.0	188	2.1	212	10.4	1,034	1.6
North Coast totals, Avg.	26	22.0	60	1.7	2,407	1.6	3,676	3.3	5,723	3.8
Mid-North:										
Salmon	142	98.6	6	17.5					145	34.5
Siletz[2]	2	100.0	5	41.9	185	2.7	153	12.4	171	1.8
Yaquina	16	37.5	6	0.0			239	1.7	1,579	0.3
Devil's Lk. & Beaver Cr.	19	21.1	13	0.0			193	1.6	527	0.8
Alsea	24	87.5	4	0.0	107	2.8	162	7.4	448	0.2
Siuslaw	9	11.1	15	6.7	351	0.9	782	1.2	3,240	0.3
Coastal lakes	647	0.0	80	1.3	54	0.0	183	0.0	3,293	0.1
Mid-North totals, Avg.	859	20.3	129	4.0	697	1.6	1,712	2.8	9403	0.8
Umpqua:										
Smith[3]	59	0.0	25	0.0	693	0.4	1,603	2.3	2,252	1.1
Mainstem Umpqua	7	14.3	17	5.9	209	3.3	508	40.8	617	5.8
Elk & Calapooya Cr.	10	10.0	13	15.4	231	3.9	158	1.3	204	2.9
South Umpqua	11	36.4	47	6.4			285	4.6	67	0.0
Cow Creek	21	14.0	34	3.0	124	21.8	498	5.1	192	1.6
Umpqua totals, Avg.	108	8.3	136	5.2	1,257	3.7	3,052	9.3	3,332	2.1
Mid-South										
Coos Bay	53	1.9	85	0.0	376	0.0	2,569	0.8	4,145	0.3
Coquille	29	0.0	40	0.0	431	0.2	1,733	6.0	880	0.9
Tenmile Lake	51	0.0	80	0.0	65	0.0	767	0.1	341	1.5
Floras Cr & New R	10	0.0	4	0.0			217	5.1	2	0.0
Mid-South Totals, Avg.	143	0.7	209	0.0	872	0.1	5,286	2.6	5368	0.4
Coast-wide *Totals, Avg.*	1,136	16.7	534	2.5	5,233	1.8	13,726	4.3	23,826	1.6

[1]2002 data is missing dead fish from North Nehalem, area of high hatchery straying.
[2]In 2002, does not include recoveries from Steer Cr., located near Siletz Tribal Release Point. With Steer Cr. recoveries, n = 435, % H = 49.4%.
[3]Includes Lower Umpqua River in 2000, 2001, and 2002

Table C.2.1.7 Proportion of natural spawning fish of hatchery origin. Data from 1990-1997 are based on scale analysis. In some cases with insufficient data ODFW reported 0.00 hatchery spawners when, in fact, hatchery spawners may have been present. Data from 1998-2002 are based on fin clips.

Management Area: Return Year													
Location	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
North Coast:													
Necanicum and Elk Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
Nehalem	0.65	0.22	0.43	0.81	0.43	0.49	0.74	0.45	0.23	0.00	0.00	0.02	0.08
Tillamook Bay	0.00	0.00	0.00	0.53	0.29	0.62	0.14	0.08	0.00	0.06	0.11	0.13	0.02
Nestucca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.02
Sand Lake and Neskowin Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00	0.00
North Coast Avg.	0.57	0.11	0.28	0.70	0.34	0.33	0.49	0.32	0.12	0.02	0.02	0.02	0.05
Mid-North:													
Salmon	0.11	0.00	0.80	0.00	0.93	0.84	0.90	0.43	0.99	0.17	1.00	0.76	0.20
Siletz	0.00	0.71	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.30	0.45
Yaquina	0.38	0.00	0.00	0.00	0.00	0.00	0.16	0.27	0.38	0.00	0.00	0.05	0.00
Beaver Creek	0.00		0.00	0.00	0.00		0.00	0.00	0.21	0.00	0.00	0.07	0.00
Alsea	0.01	0.00	0.17	0.00	0.00	0.00	0.00	0.27	0.87	0.00	0.00	0.15	0.00
Yachats	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Siuslaw	0.00	0.00	0.00	0.04	0.38	0.00	0.26	0.00	0.11	0.07	0.00	0.00	0.00
Miscellaneous	0.00	1.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00	0.00	0.00
Mid-North Avg.	0.05	0.26	0.14	0.02	0.26	0.08	0.25	0.17	0.45	0.08	0.04	0.09	0.02

Table C.2.1.7 (continued).

Umpqua:													
Lower Umpqua													
and Smith	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.03	0.01	0.02
Umpqua	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.06	0.08	0.32	0.04
Elk Creek and													
Calapooya Creek	0.00				0.00	0.00	0.00	0.00	0.10	0.15	0.03	0.02	0.00
South Umpqua	0.00	0.00		0.00	0.00	0.08	0.77	0.21	0.05	0.04	0.00	0.08	0.00
Cow Creek			0.00	0.00	0.71	0.08	0.58	0.00	0.67	0.00	0.09	0.09	0.02
Umpqua Avg.	0.06	0.00	0.00	0.00	0.13	0.01	0.43	0.08	0.09	0.03	0.05	0.14	0.02
Mid-South													
Coos Bay and													
Big Creek	0.00	0.00	0.03	0.05	0.03	0.01	0.00	0.00	0.02	0.00	0.00	0.02	0.00
Coquille	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.01
Mid-South Avg.*	0.00	0.00	0.02	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
Coast-wide Rivers	0.17	0.11	0.09	0.21	0.15	0.07	0.22	0.11	0.16	0.03	0.03	0.07	0.02
Lakes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coast-wide Total	0.17	0.11	0.09	0.21	0.15	0.07	0.22	0.11	0.16	0.03	0.03	0.07	0.02

* Excluding Floras Creek and Sixes River.